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09/932,253

08/16/2001

Chi Wu

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(LIGHT2260)

3916

7590

05/13/2004

EXAMINER

CULBERT, ROBERTS P

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ART UNIT

PAPER NUMBER

1763

DATE MAILED: 05/13/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/932,253

Applicant(s)

WU ET AL.

Examiner

Roberts Culbert

Art Unit

1763

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 April 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 96,98-125,127-146 and 169-180 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 96,98-125,127-146 and 169-180 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 0404.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

Art Unit: 1763

DETAILED ACTION

Response to Arguments

Applicant's arguments filed 3/8/04 have been fully considered but they are not persuasive.

In response to applicant's argument that Wang is nonanalogous art, it has been held that a prior art reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). In this case, Wang is concerned with forming an anisotropic (vertical sidewall) etch in a silicon substrate which is reasonably pertinent to the particular problem with which the applicant was concerned.

Applicant has argued that Wang and Miller do not provide a reasonable expectation of success since neither Wang nor Miller teach or suggest the level of smoothness that can be achieved with the Wang etch. The argument is not persuasive because Wang teaches an etch process that inherently provides the claimed smoothness level. Miller teaches formation of optical components such as waveguides from silicon in an etching process that forms vertical or nearly vertical sidewalls. Wang teaches a method of forming vertical sidewalls in a silicon substrate. There is a reasonable expectation that using the vertical silicon etching process of Wang would be successful for forming vertical silicon sidewalls in the method of Miller since Wang teaches that the disclosed process is particularly suitable for forming vertical features in silicon. This expectation of success is sufficient for one of ordinary skill in the art to combine Wang and Miller.

Applicant has argued that Wang and Miller do not teach or suggest each of the claim limitations because neither Wang nor Miller teach or suggest that the Wang etch can provide a smoothness level less than 220nm. The argument is not persuasive because Wang inherently teaches the claimed smoothness level by teaching an etch composition and process conditions that would inherently result in the smoothness claimed by applicant.

Applicant has argued that Wang does not support an inherency rejection. In support of this argument applicant has provided an Affidavit selecting process conditions in Wang that do not result in the smoothness levels claimed by applicant. However, as admitted by applicant, (Page 14 of Arguments)

Art Unit: 1763

Wang also teaches process conditions that do provide the claimed levels of smoothness. Therefore, the claimed smoothness limitation does necessarily result from process conditions provided in Wang.

Note that even if the Wang reference did not provide etch conditions that result in the claimed level of smoothness (which it does) it would have been obvious to one of ordinary skill in the art to optimize variables such as (etch gas ratio, pressure, power, etc) as the same are known to affect the etch properties and routine experimentation would have reasonably been expected to optimize them. It has been held that the discovery of an optimum value for result effective variables is within the purview of routine experimentation by the person of ordinary skill in the art. *In re Boesch*, 205 USPQ 215 (CCPA 1980).

Claim Objections

Claims 122, and 124 are objected to because of the following informalities: "*fluorine-containing includes*" should be "*fluorine-containing gas includes*". Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 172, 173, 178 and 179, are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter, which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Although the specification teaches that the etching medium may be applied continuously (without disruption) and that the etching medium can exclude application in consecutively repeated cycles (alternating etching medium and passivant, or repeating a flow rate cycle). The examiner could find no support in the specification for a constant gas flow ratio during the formation of the one or more surfaces.

Art Unit: 1763

Applicant indicates that the flow ratio may change (Paragraph 64). Similarly, there is no support found for an etch process in which all of the conditions of the etch application remain constant.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter, which the applicant regards as his invention.

Claims 98, 99, 106, 107, 121, 122, 123, 124, 127, and 128 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 98, 122, 124, and 127 recite the limitation "the fluorine containing gas". There is insufficient antecedent basis for this limitation in the claim.

Claims 99, 121, 123, and 128 recites the limitation "the partial passivant". There is insufficient antecedent basis for this limitation in the claim.

Claims 106 and 107 recite the limitation "the one or more other media". There is insufficient antecedent basis for this limitation in the claims.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 96, 98-105, and 107-120 are rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent 6,127,278 to Wang.

Wang teaches a method of forming a component comprising forming a mask over a light transmitting medium so as to protect a region of the light transmitting medium and applying an etching medium including SF₆, HBr, and O₂ (Col. 2, Lines 9-11) to the light transmitting medium so as to form one or more surfaces.

Art Unit: 1763

Wang does not teach that the etched silicon ridge pattern may be used as a waveguide; however, the limitation is seen only as intended use since the claimed method does not provide any manipulative difference as compared to Wang. A recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963).

Wang does not teach the limitation of smoothness less than 220nm, however, the limitation is inherent in Wang because smoothness is a latent property resulting from etch composition and process conditions, and the method steps of Wang include an etch composition and process conditions that are the same as in the claimed invention.

Regarding Claims 108-110, Wang also teaches that the etching medium has a molar ratio of partial passivant to fluorine-containing gas of 0.1 to 10 (See Claim 4 of Wang) and a molar ratio of fluorine-containing gas to oxygen of 0.1 to 10. (See claim 5 of Wang)

Regarding Claims 102-104, Wang teaches that a pressure of 1-100 mTorr preferably 10-60 mTorr is used for the etching process. (Col. 4, Lines 17-21)

Regarding Claims 105, 107, and 132, Wang teaches that the etching medium may also contain a noble gas such as He. (Col. 4, Lines 37-41)

Regarding Claim 113, Wang teaches that the etching medium is applied in an inductively coupled plasma reactor.

Regarding Claim 118, Wang teaches that the light-transmitting medium is silicon.

Regarding Claim 111, the method of Wang forms multiple ridge structures in silicon that may function as waveguides.

Regarding Claim 112, Wang teaches the use of an oxide mask.

Regarding Claim 117, Wang teaches that the etching medium is applied continuously during formation of the one or more surfaces.

Art Unit: 1763

Regarding Claim 116, Wang does not teach the limitation of smoothness of at most 25 or 50nm, however, as stated above, the limitation is inherent in Wang because smoothness is a latent property resulting from etch composition and process conditions, and the method steps of Wang include an etch composition and process conditions that are the same as in the claimed invention.

Regarding Claims 114 and 115, since modern etchers with an etching chamber configured to etch a wafer larger than six or eight inches are well known in the art of etching silicon, as admitted by applicant (Paragraph 32 and 62 of the Specification), it would have been obvious to one of ordinary skill in the art at the time of invention to form the waveguide on a wafer having one or more dimensions with a length greater than 8 inches in order to increase the number of optical components that may be formed during the etch process.

Regarding Claims 119, and 120, etch uniformity is a latent property that arises from the etching composition, etching apparatus, and process conditions. Since the process materials (silicon and etching medium) and process conditions (pressure, molar ratio) and apparatus (inductively coupled plasma) are the same in the cited references and the claimed invention, the limitation is inherent in the method of Wang or arises from limitations not present in the claim. Furthermore, It is clear from applicant's disclosure that etchers were know at the time of invention to be capable of providing the claimed level of etch uniformity (See Paragraph 62). It would have been obvious to one of ordinary skill at the time of invention to use an etching apparatus with a uniformity of less than 10% for example, in order to provide an etched surface with uniform surface properties as this advantage is well known in the etching art.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Art Unit: 1763

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 96, 98-105, 107-120, 125-130, 132-146, and 169-180 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 4,927,781 to Miller in view of U.S. Patent 5,874,362 to Wang

Referring to figure 2, Miller teaches a method for forming an optical component that includes forming an oxide mask (16) over a light-transmitting medium (14) so as to protect a region of the light-transmitting medium where a waveguide is to be formed; and applying an etching medium to the light-transmitting medium so as to form one or more waveguide surfaces using plasma etching (Col. 3, Lines 35-57). Referring to Figure 1, Miller likewise shows obtaining an optical component having a light-transmitting medium (14) positioned over a base (10) and applying an etching medium to the light-transmitting medium so as to form one or more waveguide surfaces as required by Claim 125.

Miller does not teach the etching composition for the plasma etching, however Miller does teach that it is well known in the art of forming waveguides to use silicon for the light transmitting medium (Col. 1, Lines 20-43).

Wang teaches a method of forming vertical features (Fig.1) in silicon by applying an etching medium including SF_6 , HBr , and O_2 (Col. 2, Lines 9-11).

It would have been obvious to one of ordinary skill in the art at the time of invention to use the silicon etching composition of Wang to etch the silicon light-transmitting medium of Miller because Wang demonstrates a method that is exceptionally well suited to fabricating the device structures of Miller. For example, Wang teaches a method of etching a ridge structure with vertical sidewalls in silicon.

Art Unit: 1763

Furthermore, Wang provides the necessary details in order to etch the structures. One of ordinary skill in the art would have been motivated to use the etching medium of Wang in order to provide a composition that will etch the silicon light-transmitting medium of Miller with vertical sidewalls and at high etch rates as taught by Wang.

Wang does not teach the limitation of smoothness less than 220nm, however, the limitation is inherent in Wang because smoothness is a latent property resulting from etch composition and process conditions, and the method steps of Wang include an etch composition and process conditions that are the same as in the claimed invention.

Regarding Claims 108-110, and 133-135 Wang also teaches that the etching medium has a molar ratio of partial passivant to fluorine-containing gas of 0.1 to 10 (See Claim 4 of Wang) and a molar ratio of fluorine-containing gas to oxygen of 0.1 to 10. (See claim 5 of Wang)

Regarding Claims 102-104, 129 and 130, Wang teaches that a pressure of 1-100 mTorr preferably 10-60 mTorr is used for the etching process. (Col. 4, Lines 17-21)

Regarding Claims 105, 107, and 132, Wang teaches that the etching medium may also contain a noble gas such as He. (Col. 4, Lines 37-41)

Regarding Claims 113 and 139, Wang teaches that the etching medium is applied in an inductively coupled plasma reactor.

Regarding Claims 118 and 144, Miller teaches that the light-transmitting medium is silicon.

Regarding Claims 111, 136, and 137, Miller teaches that a plurality of waveguides may be formed in the etch process. Wang also shows multiple ridge structures in silicon that may function as waveguides.

Regarding Claim 112, Both Wang and Miller teach the use of an oxide mask.

Regarding Claims 117, 143, and 177, Wang teaches that the etching medium is applied continuously during formation of the one or more surfaces.

Regarding Claims 116, 142, 169, and 175, Wang does not teach the limitation of smoothness of at most 25 or 50nm, however, as stated above, the limitation is inherent in Wang because smoothness is a latent property resulting from etch composition and process conditions, and the method

Art Unit: 1763

steps of Wang include an etch composition and process conditions that are the same as in the claimed invention.

Regarding Claims 114, 115, 140, and 141, since modern etchers with an etching chamber configured to etch a wafer larger than six or eight inches are well known in the art of etching silicon, as admitted by applicant (Paragraph 32 and 62 of the Specification), it would have been obvious to one of ordinary skill in the art at the time of invention to form the waveguide on a wafer having one or more dimensions with a length greater than 8 inches in order to increase the number of optical components that may be formed during the etch process.

Regarding Claims 119, 120, 145 and 146, etch uniformity is a latent property that arises from the etching composition, etching apparatus, and process conditions. Since the process materials (silicon and etching medium) and process conditions (pressure, molar ratio, flow rates) and apparatus (inductively coupled plasma) are the same in both the cited references and the claimed invention, the limitation is either inherent in the method of Wang or arises from limitations not present in the claim. Furthermore, It is clear from applicant's disclosure that etchers were know at the time of invention to be capable of providing the claimed level of etch uniformity (See Paragraph 62). It would have been obvious to one of ordinary skill at the time of invention to use an etching apparatus with an etch uniformity of less than 10% for example, in order to provide an etched surface with uniform surface properties as this advantage is well known in the etching art.

Regarding Claims 170 and 176, Wang teaches that the one or more surfaces are formed in a single etch step in both the prior art method (Col. 2, Lines 9-11) and in the second step of Wang (see explanation below)

Regarding Claims 171, and 177, Wang teaches that the etching medium is applied continuously

Regarding Claims 172, and 178, Wang teaches that the conditions under which the etching medium is applied may remain constant (See Example 1) or may vary to control etch rate (Col. 5, Lines 50-54)

Regarding Claims 173 and 179, Wang teaches that the gas flow ratio remains constant during the formation of the one or more surfaces since the gas flow rates provided in Wang are constants.

Art Unit: 1763

Regarding Claims 174, and 180, Wang teaches that the pressure at which the etching medium is applied remains constant during the formation of the one or more surfaces since the pressure is provided as a constant value.

Regarding the two step process in Wang, even though Wang teaches a two step process, the second step which uses an etching medium including SF₆, HBr, and O₂, forms a surface in a single step, continuously, and with constant etch conditions including gas flow ratio. The second step of Wang, therefore, reads on the claimed invention since the "one or more surfaces" recited in the claimed invention reads on the surface formed in the second step of Wang. Note also that applicant has also described a two step process in which multiple surfaces are formed in different etch steps (Paragraphs 53-55), but claims a surface formed in a single etch step (Claims 170, and 176).

However, note that even if Wang did not read on the one step process of the claimed invention (which it does) and the "one or more surfaces" were considered to be the same as the entire surface etched in both the first and second steps of Wang, it is clear from the entire disclosure of Wang that the two step process is a modification of the prior art one step processes in which an etching medium including SF₆, HBr, and O₂ is used in a one step process to form the entire surface and is only unfavorable when using a nitride mask. See (Col. 2, Lines 6-44 of Wang) Support for this prior art method is also found, for example, in U.S. Patents 4,816,098 to Davis (Col. 51, Line 65 - Col. 52, Line 30) and U.S. Patent 5,423,941 to Komura (Col. 4, Lines 23-27)

It would have been obvious to one of ordinary skill in the art at the time of invention to form the etched surfaces in a conventional one-step process using an etching medium including SF₆, HBr, and O₂ since the composition is well-known in the art and Wang teaches that the composition provides anisotropic (straight walled) surfaces at high etch rates.

Claims 106 and 131 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 4,927,781 to Miller in view of U.S. Patent 5,874,362 to Wang as applied above, and in further view of U.S. Patent 4,816,098 to Davis.

Art Unit: 1763

As applied above, Miller in view of Wong teaches the method of the invention substantially as claimed, but does not teach that the etching medium also includes SiF_4 or SiF_6 .

Davis teaches that it is known in the art of etching vertical sidewalls in silicon to use an etching composition including SF_6 , HBr and oxygen. (Col. 51, Line 45 – Col. 52, Line 23) Davis further teaches that it is known to use a chemistry including a fluorosilane such as SiF_4 (Col. 52, Lines 24-30)

It would have been obvious to one of ordinary skill in the art at the time of invention to use one of the conventional etch chemistries including a fluorosilane such as SiF_4 in order to provide a high rate anisotropic etch and also to provide good selectivity to photoresist as taught by Davis.

Claims 121-124 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 4,927,781 to Miller in view of U.S. Patent 6,303,512 to Laermer.

Referring to figure 2, Miller teaches a method for forming an optical component that includes forming an oxide mask (16) over a light-transmitting medium (14) so as to protect a region of the light-transmitting medium where a waveguide is to be formed; and applying an etching medium to the light-transmitting medium so as to form one or more waveguide surfaces using plasma etching (Col. 3, Lines 35-57). Referring to Figure 1, Miller likewise shows obtaining an optical component having a light-transmitting medium (14) positioned over a base (10) and applying an etching medium to the light-transmitting medium so as to form one or more waveguide surfaces as required by Claim 125.

Miller does not teach the etching composition for the plasma etching, however Miller does teach that it is well known in the art of forming waveguides to use silicon for the light transmitting medium (Col. 1, Lines 20-43).

Laermer teaches a method of forming vertical features (Fig.1) in silicon by applying an etching medium including a fluorine-containing gas, one or more partial passivants, and oxygen. Laermer teaches that the fluorine containing gas may be SF_6 or NF_3 optionally mixed with argon (Col. 2, Lines 37-40). Oxide formers such as oxygen and a secondary reactant such as SiF_4 are used for sidewall passivation (Col. 2, Lines 40-53). Laermer also teaches that CHF_3 , C_4F_8 , CF_4 , C_2F_6 , or C_3F_8 may be added to the gas mixture to accelerate the breakdown of Si compounds (Col. 3, Lines 52-56).

Art Unit: 1763

It would have been obvious to one of ordinary skill in the art at the time of invention to use the vertical silicon etching composition of Laermer to etch vertical sidewalls in the silicon light-transmitting medium of Miller because Laermer demonstrates a method that is exceptionally well suited to fabricating the device structures of Miller. For example, Laermer teaches a method of etching a ridge structure with vertical sidewalls in silicon. Furthermore, Laermer provides the necessary details in order to etch the structures. One of ordinary skill in the art would have been motivated to use the etching medium of Laermer in order to provide a reliable etching operation which is resistant to malfunction and to allow lower substrate temperatures as taught by Laermer (Col. 2, Lines 30-33).

Miller in view of Laermer does not teach the limitation of smoothness, however, the limitation is inherent in Laermer because smoothness is a latent property and the method steps of Laermer are the same as in the claimed invention.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

U.S. Patent 5,423,941 to Komura et al. (Col. 4, Lines 23-27) teaches etching vertical sidewalls in silicon using a mixture of SF_6 , HBr and O_2 .

U.S. Patent 6,380,095 to Liu et al. teaches a method of anisotropically etching silicon using an etching medium comprising a fluorine source such as (SF_6 , CHF_3 or NF_3) and a silicon source such as (SiH_4 or SiBr_4)

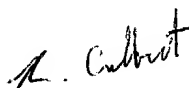
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Roberts Culbert whose telephone number is (571) 272-1433. The examiner can normally be reached on Monday-Friday (7:30-4:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Gregory Mills can be reached on (571) 272-1439. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Art Unit: 1763

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

R. Culbert




GREGORY MILLS
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